ABSENCE OF GASTRIC ULCERATION IN RATS AFTER FLIGHT ON THE COSMOS 782 BIOLOGICAL SATELLITE

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ABSTRACT

Evidence of gastric ulceration or severe erosion of the gastric mucosa was sought in rats following 19.5 days of spaceflight on the Cosmos 782 Biological Satellite. The stomachs from the flight animals were compared macroscopically and histologically with stomachs removed from animals in the synchronous and vivarium control groups. None of the animals in the flight or the control groups ulcerated, and there were no obvious histologic differences in gastric erosion among the groups. The reasons for this failure to ulcerate are discussed.

INTRODUCTION

A variety of environmental stressors can be shown to produce gastric ulceration in rats (1,2,5,12,13). Several converging lines of research have shown that endogenous histamine plays an essential role in stress-produced gastric ulceration (6,9), and recently Brown et al. (4) demonstrated that the mechanism specifically involves the H2 receptor for histamine. Pfeiffer (8) has reviewed evidence that certain of the stresses associated with spaceflight can produce changes in histamine levels in the gastrointestinal mucosa. Whether the actual stresses associated with modern long-term spaceflight are sufficient to produce gastric ulceration in rats is uncertain. The purpose of the present study was to determine the extent, if any, of gastric ulceration in rats subjected to 19.5 days of spaceflight aboard the Cosmos 782 Biosatellite.

METHODS

Male Wistar-line rats weighing between 250 and 300 g were divided into flight, synchronous control and vivarium control groups (Table 1). For the ulceration study, the stomachs were removed from 6 animals in each of the three groups. All 6 animals from the flight group received injections of $^{C-14}$ glycine, listeria and declomycin. Five of the animals taken from the synchronous control group received injections of listeria and declomycin. None of the rats from the vivarium control group received any of the drugs. The administration of these drugs was required for other experiments which were concurrently performed on these animals.

A special diet developed for weightless conditions was delivered four times a day at 6-hr intervals to animals in all groups. Water was avail-

TABLE 1

EXPERIMENTAL CONDITIONS AND EXTENT OF GASTRIC ULCERATION

Group	N	Number of ulcers		
		Petechial	Punctate	Longitudinal
Flight[1]	6	0	0	0
Synchronous[2]	6	0	0	0
Vivarium[3]	6	0	0	0

[1]All rats injected with $^{C-14}$ glycine, declomycin and listeria

[2]Five rats injected with declomysin and listeria

[3]None of the rats received any of the drugs

able ad libitum. Details of the environmental conditions and hardware used to house the animals are described elsewhere (14).

The stomachs were removed from the flight animals within 5 to 11 hr after landing of the biosatellite and they were removed from the synchronous and vivarium control groups five to six days later. An incision was made on the ventral surface of each rat and the stomach was removed, cut along the greater curvature, rinsed with tap water to remove any contents, and placed in a vial containing buffered neutral formalin. The stomachs were examined macroscopically for gastric ulceration using the following classification (7): (a) Petechial ulcers: minute superficial erosions involving only the mucosa; (b) Punctate ulcers: discrete punched out ulceration measuring at least 1 mm; and (c) Longitudinal ulcers: continuous linear ulceration larger than 1 mm.

Tissue for histological examination was taken from the rumen, corpus and antrum from animals in each of the groups, embedded in paraffin and sectioned at 8u. Hematoxylin and eosin stained sections were examined microscopically for evidence of superficial erosion of the mucosa.

RESULTS

The results of the macroscopic examination of the gastric mucosa were unequivocal. None of the animals examined from the three experimental groups evidenced gastric ulcers or pronounced mucosal erosion (Table 1). It should be pointed out that macroscopic detection of very small petechial ulcers in formalin-fixed tissue is difficult. However the failure to find petechial ulcers was supported by microscopic examination of the H & E material, which also revealed no significant differences in gastric erosion in animals from the three groups.

DISCUSSION

The present investigation indicates that the rats subjected to prolonged spaceflight on the Cosmos 782 Biosatellite failed to evidence gastric ulceration or pronounced mucosal erosion upon return. For several reasons, this failure to ulcerate was not unexpected. First, all the animals were regularly fed four times a day at 6-hr intervals. In order to produce experimental stress ulcers in rats, a minimum of 24-hr of food deprivation is usually required (3). Second, in conjunction with other experiments, most of the animals in the flight and synchronous control groups were maintained on the antibiotic, declomycin (Table 1). Certain antibiotics have been shown to prevent or reduce gastric ulceration in rats (7,11). It has been found (7) that reductions in the bacterial flora of the gut with broad spectrum antibiotics can result in a deficiency of pyridoxal phosphate, which is a required co-factor in the biosynthesis of histamine. Other evidence has demonstrated that histamine depletion can afford protection against experimental ulcers in rats (10,15). Third, it is known that recovery from stress ulcers in rats is essentially complete within a few days (1); and unlike gastric ulceration in man, there is no residual scarring in rats. It is therefore possible that during the initial phases of the spaceflight, the animals did ulcerate, but recovered prior to the return of the biosatellite. The preceding considerations are probably sufficient to account for the failure of the rats to ulcerate. However it should also be kept in mind that the conditions of spaceflight on Cosmos 782 may have been considerably less stressful than the experimental procedures typically devised (2,4,13) to produce stress ulcers in rats.

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